THE

SCHOOL OF MINES and METALLURGY.

A DEPARTMENT OF
THE UNIVERSITY OF MISSOURI.

CATALOGUE.

~~1898-1900.~~
1899-1900

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ROLLA, MO.

Twenty-Eighth Annual Catalogue

OF THE

School of Mines and Metallurgy

A DEPARTMENT

OF THE

University of the State of Missouri,

ROLLA, MO.

1899.

The Rolla Herald,
Rolla, Mo.
1899.

CALENDAR.

1899.

June 14, Wednesday, 10 a. m., -	Annual Commencement.
September 16 and 18, Saturday and Monday, 10 a. m., - -	Entrance Examination.
September 19, Tuesday, - -	First Term Begins.
November 23, Thursday, -	Thanksgiving Holiday.
December 22, Friday, at 12 a. m., -	Christmas Recess Begins.

1900.

January 2, Tuesday, - - -	Second Term Begins.
February 22, Thursday, - -	Holiday.
March 19, Monday, - - -	Third Term Begins.
June 12, Tuesday, - -	Annual Meeting of Executive Committee.
June 13, Wednesday, - - -	Commencement.

BOARD OF CURATORS

OF THE

University of the State of Missouri.

To January 1, 1905.

To January 1, 1901.

Gardiner Lathrop, Esq., - - -	Kansas City.
Hon. M. E. Benton, - - - - -	Neosho.
O. D. Jones, Esq., - - - -	Edina.

To January 1, 1903.

Rev. John D. Vincil, D. D., - -	St. Louis.
Noah M. Given, Esq., - - - -	Harrisonville.
H. C. Well, Esq., - - - -	Platte City.

OFFICERS OF THE BOARD.

Rev. John D. Vincil, D. D., - - -	President.
Noah M. Given, - - - - -	Vice-President.
J. G. Babb, - - - - - -	Secretary.
R. B. Price, - - - - - -	Treasurer.

EXECUTIVE COMMITTEE

OF THE

School of Mines and Metallurgy.

Rev. John D. Vincil, D. D., - - -	St. Louis.
Hon. M. E. Benton, - - - - -	Neosho.
Hon. J. T. Moore, - - - - -	Lebanon.

OFFICERS OF THE COMMITTEE.

John D. Vincil, - - - - - - -	Chairman.
Charles L. Woods, - - - - -	Secretary.
Henry Wood, - - - - - -	Treasurer.

FACULTY.

RICHARD H. JESSE, LL. D., . - *President of the University.*

GEORGE E. LADD, PH. D., *Director and Professor of Geology and Mining*, A. B., 1887, A. M. 1888, Ph. D., 1894, Harvard University.

ELMO G. HARRIS, C. E., - - - *Professor of Engineering.*
C. E., University of Virginia, 1882.

ARTHUR H. TIMMERMAN, M. M. E., - - *Professor of Physics.*
B. S., College of City of N. Y., 1891;
M. E. 1892, M. M. E., 1893, Cornell University.

EUGENE T. ALLEN, PH. D., - - - *Professor of Chemistry.*
A. B., Amherst College, 1887:
Ph. D., John Hopkins University, 1892.

GEORGE R. DEAN, C. E., - - - *Professor of Mathematics.*
C. E., 1890; B. S., 1891, Missouri School of Mines.

F. W. DRAPER, E. M., - - - - *Professor of Metallurgy.*
E. M., Massachusetts Institute of Technology, 1895.

PAUL J. WILKINS, B. S., *Secretary and Instructor in Academic Department.* B. S., Michigan A. & M. College, 1869.

JOHN B. SCOTT, - - - - - - *Instructor in English.*

ARTHUR D. TERRELL, - - - - *Instructor in Drawing.*
B. S., Missouri School of Mines, 1898.

GEORGE C. CLARK, - - - *Assistant in Chemical Laboratory.*

....*Assistant in Physical Department.*

TEACHING FELLOWS.

R. H. HATCHETT, - - - - *Instructor in Shop Work.*

E. T. PERKINS, - - - *Assistant in Chemical Laboratory*

Director of the School,
GEORGE E. LADD.

Secretary of the Faculty,
PAUL J. WILKINS.

Librarian,
MAUDE B. MITCHELL.

Engineer,
ROBERT DICKERSON.

Stenographer,
JESSIE HELLER.

HISTORY.

In 1870 the General Assembly of Missouri in accepting the donation of land for educational purposes made by the General Government through Act of Congress, approved July 2, 1862, established an Agricultural and Mechanical College and a School of Mines and Metallurgy. The design of these institutions is set forth in the following language:

Objects of the Colleges.—The leading objects of said colleges shall be to teach such branches as are related to agriculture and the mechanic arts and mining, including military tactics, and without excluding other scientific and classical studies, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. (R. S. 1889, Sec. 8739.)

The Agricultural and Mechanical College was located in Boone County; the School of Mines and Metallurgy was to be located in that county of Southern Missouri which should offer the greatest inducements for such location. A commission was appointed to receive and pass upon proposals in accordance with this act, and after mature investigation and deliberation pronounced in favor of Phelps County. Here, in the next year (1871), the School of Mines began its active existence.

The statutes fix the *status* of the School as one of the colleges of the State University. Its affairs are immediately under the supervision of an Executive Committee, consisting of three members of the University Board of Curators, selected by that body.

The need of general culture as a foundation and accompaniment of specifically technical training and the prevailing absence of facilities for gaining this from the reach of the intended beneficiaries of the institution, led to the establishment in 1885 of an Academic Course in compliance with the following Act of Assembly:—

ACADEMIC COURSE OF STUDY, ETC.—That the obligations of the State to the general government, assumed by the acceptance of the land grant of July 2, 1862, may be more fully discharged, and in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, the Board of Curators of the State University shall prescribe and adopt a liberal Academic Course of Study to be taught in the College of Mines and Metallurgy, located at Rolla, in addition to the courses now taught in said school, and may confer the degree of Bachelor of Science upon all students who shall complete said course in said school to the satisfaction of the faculty thereof. (R. S., Sec. 8740.)

The School of Mines is organized and conducted with a view to subserving, as efficiently as possible, the ends set forth in the legislative enactments in reference to it. An Academic Course, as provided for in the act above quoted, is maintained.

FINANCES.

The proceeds from the sale of the public lands granted by the General Government amount to about $350,000, which is invested in State certificates of indebtedness bearing 5 per cent. interest. The School of Mines receives one-fourth of the yearly income thus accruing. By an Act of Congress approved August 30th, 1890, commonly known as the "Morrill Bill," the general government donated to each State and territory, maintaining a college or colleges in accordance with the act of July 2d, 1862, $15,000 for the year 1889-90, which should be increased by $1,000 a year until the donation shall reach $25,000 a year, this to remain thenceforth an annual appropriation. After deducting one-sixteenth of this fund for the Lincoln Institute, Missouri gives one-fourth of the remainder to the School of Mines.

In 1891, the government returned to the various States the sums collected from their citizens by the imposition during the Civil War of a "direct tax." The amount thus refunded to Missouri was $646,958.33, and the 36th General Assembly of the

State won the gratitude of the friends of higher education by establishing this as a permanent endowment for the State University, specifically designating one-fifth as the portion of the income from this source which should belong to the School of Mines. The investment of the fund in 5 per cent. State certificates yields to the school annually $6,469.58.

LOCATION.

The School of Mines is situated at Rolla, the county seat of Phelps County, on the St. Louis and San Francisco R. R., approximately half way between St. Louis and Springfield. It has an elevation of 1,140 feet above the sea level, and enjoys an agreeable and notably healthful climate. Not infrequently families from less favored climates move hither, seeking at once the health of the older members, and the education of the younger. Its position on a great transcontinental railway system renders it readily accessible from all quarters. It is within easy reach of the lead and zinc district of the southwest, and of the lead and iron region of the southeast, while opportunities to observe processes of mining and smelting the latter ores are close at hand. The numerous and varied smelting and chemical plants in and about St. Louis likewise offer good opportunities for the study of the processes.

GROUNDS.

The grounds of the School of Mines are situated in the highest part of the town of Rolla, and are somewhat over twenty acres in extent. The recent purchase of the lot intervening between the Campus proper and the "Park" has united the holdings of the school into a single continuous tract.

Important improvements have recently been made. The whole campus has been graded and sown in grass. A low stone wall, surmounted by an iron fence, has been constructed about the southern and eastern sides of the campus. New walks have been laid, and new trees set out.

Baseball and football grounds and an ample number of tennis courts have been laid out and are maintained in good order.

BUILDINGS AND EQUIPMENT.

The buildings are located on the enclosed campus. There are five in all, four of them being substantial brick structures.

MINING AND METALLURGICAL BUILDING.

The special building for the Department of Mining and Metallurgy, finished in 1895, is equipped with the necessary appliances for a practical course in ore concentration, roasting and reduction.

The building consists of two distinct portions, one containing a chemical and a mineralogical laboratory, lecture room, reference library, draughting room, petrographical laboratory, blue print room, etc.; the other comprising a large mill room, an engine room, and a boiler room. The mill room is equipped with first-class modern machinery, of standard sizes, for crushing and concentration of ores, the plant containing a Dodge Rock Breaker, Cornish Rolls, Stamp Battery with Automatic Feeder, Calumet Hydraulic Classifier, Inlet Discharge Separator, Hartz Jig, Spitzkasten, Parsons-Rittinger Percussion Tables, Frue Vanner, Grinding and Amalgamating Pan and Settler, with Settling Boxes. In addition to these, working models of different types of concentrators have been made by students of the School of Mines and contributed to its outfit. The reduction plant consists of a Reverberatory Roasting Furnace, and 20-inch Water-jacket Cupola Furnace, with Root Blower, for lead and copper ores. There are also assay and cupellation furnaces, and before the beginning of next term it is hoped that a zinc distillation furnace will have been erected. A barrel chlorination outfit has also been added during the past year, and the Ingersoll-Sergeant Drill Co. has presented the school with one of its steam and compressed air drills, with which the classes in mining are given experience in drilling.

The Metallurgical department is also equipped with clay testing apparatus, including the latest type of German made special fire-clay testing furnace and accessories, and also the Keiser and Schmidt modifications of LeChatilier's thermo-electric pyrometer for the measurement of high temperature.

The power for the above plant is derived from a 50 H. P. automatic engine, taking steam from two 35 H. P. tubular boilers.

By means of this excellent equipment students receive practical instruction in the crushing and concentration of various ores, and in the metallurgical treatment of ores of lead, zinc, copper, gold and silver. The Geological and Mineralogical equipment is also in this building.

This includes a representative collection of 1,000 specimens of minerals for class use; 200 specimens of rocks; 200 specimens of typical fossils; a large collection illustrating metallurgical processes; a collection of 500 specimens of ore from the World's Fair. To this, additions are being made from time to time.

This material has been greatly augmented by the acquisition in 1895 of the entire Missouri Mineral Exhibit collected for display at the World's Fair at Chicago, which by act of the State Legislature became part of the permanent equipment of the School of Mines. This collection contains 3,529 specimens representing the mineral wealth of Missouri, consisting of ores of lead, zinc, iron and copper, coal, clays of many sorts, and building stones. Many of the specimens are of extraordinary size and rare beauty. The minerals occurring as gangue with the metalliferous deposits of the State are also well represented. Altogether it is an unusually valuable assemblage of geologic products of economic importance.

A full set of instruments for geological surveys constitutes a portion of the outfit of this department.

CHEMICAL LABORATORY.

The Chemical Laboratory is a substantial, well-lighted brick building, devoted entirely to the work of the chemical department. It contains qualitative, quantitative and assay laborato-

ries, lecture room, preparation room, balance room, stock room, private laboratory, and office.

The qualitative laboratory is 47x25 feet, and has working places for twenty-eight students at a time. The cupboards and drawers are duplicated throughout so that double that number can be accommodated. This laboratory is also used by workers in General Chemistry, and its accommodations are excellent.

All drawers and cupboards in both laboratories are fastened by combination locks so that each student may be held responsible for his own apparatus.

The assay laboratory has recently been renovated. It has a concrete floor and is practically fire-proof. There are four muffle furnaces, carrying muffles 16x10 inches. These are encased in galvanized iron hoods connecting with ventilating flues, which carry off lead fumes and superfluous heat. The equipment also includes one small gasoline Hoskins' furnace, carrying 8x4½ inch muffle, Hoskins' furnace with 15x9 inch muffle, and one wind furnace. The laboratory is conveniently fitted with sink, cupboards, balances and apparatus for crushing and sifting.

The balance-room is abundantly provided with analytical and assay balances. The general equipment is excellent and is being constantly increased.

LECTURE HALL AND PHYSICAL LABORATORY.

In this building are general lecture rooms, an Assembly room, the Library, Drawing room, and the Physical and Engineering departments.

It is equipped with toilet rooms, and is heated with steam.

Physical Laboratory.—This occupies three large rooms, and is well supplied with standard apparatus. Part of the Electrical equipment is in this department.

Additions to the equipment are constantly being made.

The Civil Engineering Department.—This also occupies three rooms in this building. Its equipment for Field practice includes a Heller and Brightly Transit with Solar Attachments; a Gurley Construction Transit; a Saegmuller Transit; a Plane Ta-

ble with Stadia Attachments; a Gurley Y Level; a Buff and Berger Y Level; a Keuffel and Esser Level; a Gurley Solar Compass; a Gurley Vernier Compass; two Sextants; a Lock Level, with the necessary Level Rods, Chains, etc.

Tests of cement are made with a Riehle Bros.' U. S. Standard Cement Testing Machine. A Steam Calorimeter, a Thompson's Steam Engine Indicator, and a Dynamometer are used in the instruction in Steam Engineering, and a 15 H. P. Otto Gasoline Engine has recently been added to the equipment of this department.

LIBRARY.—The Library contains nearly 4,000 carefully selected volumes. Good collections of works upon Engineering, Mathematics, Chemistry, Physics, Mining and Metallurgy, afford to students in these departments an opportunity to pursue an extended course in reading in connection with their class work. The Library also contains the standard works in English and American Poetry, Fiction, Biography, and History. It is well provided with encyclopaedias and works for general reference. It is open and in charge of the Librarian from 8:30 a. m. to 12:30 p. m., and from 7 to 9 p. m. During these hours books may be taken out and the Library room used for reading and study. The following periodicals for the current year are found on the reading tables of the Library:

Atlantic Monthly.
American Journal of Science.
Annals des Mines.
American Geologist.
American Chemical Journal.
Annals de Chimie et de Physique.
Annals of Mathematics.
Age of Steel.
Berg und Huttenmannische Zeitung.
Century.
Chemical News.
Cosmopolitan.
Columbia Herald.
Electrical World.
Electrician (London).
Engineering (London).
Engineering World.
Engineering News.
Engineering and Mining Journal.
Engineering Record.
Educational Review.
Journal of American Chemical Society.
Ladies' Home Journal.
Life.
Literary Digest.
McClure's Magazine.
Mining Industry and Review.
Mines and Minerals.
Mining and Scientific Press.
Mining Reporter.
Mining World.
Missouri School Journal.
Modern Machinery.
Munsey's Magazine.
Nation.
North American Review.
Official Gazette.
Physical Review.
Philosophical Magazine (London.
Scribner's Magazine.
Stahl und Eisen.

Forum.
Harper's Monthly.
Harper's Weekly.
Journal Franklin Institute.
Journal of Geology.
State's Duty.
Technology Quarterly.
Transactions American Society of Civil Engineers.
Week's Current.
Zeitschrift fur Analytische Chemie.

DORMITORY.

This is a three story, brick building, containing 30 student rooms and provided with a large and attractive dining room, kitchen, etc. It has hitherto been conducted as a dormitory and "club house," the students' meals being served in the building at a cost varying from $9.50 to $11.50 per month.

The rooms are equipped with the simple necessary furniture, students providing their own bedding and towels, and paying pro rata for the fuel consumed in the heating of the building.

No charge is made for room rent, but a contingent deposit must be made to the Treasurer of the School of Mines to cover damages for which the depositor may be responsible.

The past year the building has been used as a dormitory, the students rooming there only, and taking their meals at boarding houses in the vicinity.

The large dining hall and the adjacent rooms have been used for gymnasium purposes.

DYNAMO LABORATORY AND SHOPS.

This is a capacious wooden structure, necessitated by the rapid growth of the wood-working department and the need of more room for students engaged in electrical laboratory work. It is well lighted and is well equipped with carpenter benches tools, wood and iron lathes, etc. The machinery is run by electricity from a dynamo in the engine room of the Mining building.

The Dynamo Laboratory contains as a part of its equipment, one 75 light United States Dynamo, one 5 horse power Westinghouse Motor, one 5 horse power C. & C. Motor, one alternator, one 4-phase generator and a transformer, with all necessary testing apparatus.

ADMISSION.

Under the statutes persons of either sex, sixteen years of age or over, whether residents of Missouri or not, are admissible upon evidence of sufficient preparation. Students should acquire a good liberal education, its elements at least, before beginning technical study. Age is not an infallible criterion of advancement, but, as a rule, they would do best to continue their general studies until they are seventeen or eighteen. The average age of the present Freshman Class at entrance was about 18. The general test of admittance is, however, the fitness of the applicant to pursue profitably the courses here offered. Specific requirements have been fixed by considerations of the express design of the school—"to promote the education of the industrial classes" in certain branches of engineering—and of the educational opportunities of its intended beneficiaries. The school does not wish to do the work customarily done in the public schools throughout the State, neither does it intend to set its entrance conditions beyond the reach of the majority of those whose interests were chiefly contemplated in its establishment. The requirements for admission to the Freshman Class for the fall of 1899 are as follows:

The applicant must file with the Director a certificate of good moral standing.

Admission by Diploma.—Applicants may be admitted upon certificate from a college or a preparatory school, when the faculty is satisfied that the work certified to covers the above requirements.

Following is a list of schools whose courses have been approved by the University, and whose diplomas will admit to the Freshman Class without examination.

Boonville High School, Boonville.
Buchanan College, Troy.
Butler Academy, Butler.
Cameron High School.
Chillicothe High School.
Culver Military Academy, Culver, Ind.
Kansas City Manual Training School
Keokuk (Iowa) High School.
Lamar High School.
Lancaster High School.
Lexington High School.
Louisiana High School.
Macon High School.

Columbia High School.
Hannibal High School.
Kansas City High School.
Kemper Family School, Boonville.
Kirkwood High School.
Michigan Military Academy, Orchard Lake.
Marshall High School.
Mary Institute, St. Louis.
Paris High School.
Quincy (Ill.) High School.
Sedalia High School.
Slater High School.
Smith Academy, St. Louis.
St. Joseph High School.
St. Louis High School.
University Academy, Columbia.
Wentworth Military Academy, Lexington.
Woodson Institute, Richmond.
Appleton City Academy, Appleton City.
Bethany High School.
Cairo (Ill.) High School.
Carthage High School.
Carrollton High School.
Clinton High School.
East St. Louis (Ill.) High School.
Fort Smith High School, Ft. Smith, Ark.
Greenville (Miss.) High School.
Harrisonville High School.
Higginsville High School.
Independence High School
Jefferson City High School.
Joplin High School.
Maryville High School.
Miami High School.
Mexico High School.
Moberly High School.
Monroe City High School.
Mound City High School.
Montgomery City High School.
Nevada High School.
Oregon High School.
Richmond High School.
Rockport High School.
Shelbina High School.
Springfield High School.
Trenton High School.
Webb City High School.
Westport High School.
Brookfield College, Brookfield.
Carthage Fitting School, Carthage.
Iberia Academy, Iberia, Mo.
King City High School.
Kidder Institute, Kidder.
Mt. Vernon Academy, Mt. Vernon.
North Mo. Acanemy, Salisbury.
Uriver Mil. School, Mobile, Ala.
Vandalia High School.
Watson Seminary, Ashley.
Marionville Collegiate Institute, Marionville.
Brookfield High School.
Christian College, Columbia.
Greenfield High School.
Kirksville High School.
Poplar Bluff High School.
Rich Hill High School.
Rogers Academy, Rogers, Ark.
Windsor High School.

Admission by Examination.—Applicants for admission not having diplomas from approved schools, must offer themselves for examination on eight of the following subjects, and must pass, satisfactorily, six of these subjects, including Algebra and Plane Geometry. Conditions must be made up before the close of the Freshman year :—

1. English. English Grammar and Composition.

2. History. The equivalent of Myers' General History.

3. Algebra. The equivalent of Milner's High School Algebra, through quadratic equations.

4. Plane Geometry. The equivalent of Phillips' and Fisher's Plane Geometry.

5. Physics. One year's work in a good high school.

6. Chemistry. One year's work in a good high school.

7. German. The equivalent of one year's work in a good high school.

8. French. The equivalent of one year's work in a good high school.

9. Botany. One year's work in a good high school.

10. Zoology. One year's work in a good high school.

ADVANCED STANDING.—Candidates may be admitted to "advanced standing" (that is to enter the Sophomore or the Junior class) either upon examination in the subjects of the previous year or years, or upon certificate from another institution of work accomplished, which is, in the estimation of the Faculty, equivalent to that completed here by the class into which entrance is sought. Applicants for advanced standing should communicate with the Director as early as possible.

SPECIAL STUDENTS.

Under certain circumstances the courses offered at the School are open to special students who are of such maturity and who evince such seriousness of intention, as to indicate that they are likely to pursue their work with profit.

These students are admitted without examination, and are not considered candidates for degrees.

When the work is chiefly of a laboratory nature they will be required to take at the same time as much class-room work as the Faculty may designate for each particular case.

Since there are many persons who would profit by the opportunities for education offered at the school, but who are unable, through lack of time or preliminary training to undertake the work of the regular courses, the Faculty has made the above provision. In this way it hopes to broaden the usefulness of the school, and to enable it to fulfill its purpose in as liberal a manner as possible.

As a guide in the selection of work for the average special student certain special courses are outlined. (See page 20.)

DEGREES.

1. The degree of Bachelor of Science in Mining Engineering, Bachelor of Science in Civil Engineering or Bachelor of Science in Chemistry and Metallurgy, will be conferred on students who have attained the required standard in all the subjects of instruction in Courses I, II, or III.

2. The degree of Bachelor of Science will also be conferred on students who have satisfactorily completed Course IV in General Science (see Academic Department and page 27.)

The degree of Master of Science will be given to students who have completed satisfactorily a year's post-graduate work in this subject in residence at the school.

3. The further degree of Mining Engineer, Civil Engineer or Metallurgical Engineer, will be conferred on one who, having previously been graduated in I, II, or III, has completed satisfactorily a year's post-graduate work in residence here, or who has had professional experience in a responsible position for not less than two years.

Each applicant for a degree is required to present to the Faculty a satisfactory thesis, recording the result of some original investigation or independent research in a subject connected with his course. It must be accompanied by any drawings that may be necessary to illustrate it, and a copy of it must be deposited with the Librarian for preservation.

COURSES OF STUDY.

It is the object of the instruction at this institution, first, to lay a broad and solid foundation in the way of acquaintance with principles and theory, and to supplement this, wherever possible, by the discipline of practical application in the laboratory and field. Lectures and recitations are arranged to come in the morning hours, leaving the afternoon for laboratory and field work. The practical work is designed to illustrate and impress principles, to familiarize the student with the use of instruments with

which he is to be concerned in the work of his profession, and to afford an opportunity for original investigation. "Head-work" and "hand-work" go together. What is taught orally in the lecture room is applied, and illustrated, in the laboratory.

The School of Mines offers four complete and several special courses, the former extend through four years, and are

I. Mining Engineering.
II. Civil Engineering.
III. Chemistry and Metallurgy.
IV. General Science.

Number I is a general course in Mining Engineering, having in view all the operations in connection with mining, from the prospecting for the mine to the delivery of the finished product on the market.

Number II is a course in Engineering as applied especially to Railways, Highways and Municipal Works.

Number III contemplates especially processes in Mining and Metallurgy subsequent to the delivery of the ore above ground. It fits a man for a position as Chemist and Assayer or in other connection with concentrating plants and smelters.

Certain options are offered as the candidate may wish to specialize in the direction of Metallurgy or of Analytical Chemistry.

Number IV is a newly offered course to begin in the fall of 1898. In the fall of 1900 it will replace the one now offered in the Academic Department. It is largely elective and provides for a liberal education in General Science.

The engineering courses are identically the same in the Freshman year, and differ but slightly in the Sophomore. The student has thus an opportunity to defer his choice of a specialty until he has spent some time in technical study, and can better estimate his inclinations and capacities.

In the course in Chemistry and Metallurgy those who wish to become chemists, rather than metallurgists, may substitute equivalent chemical work for Stereotomy and Masonry Construction, while those having in view metallurgy rather than chemistry have the same privilege as regards Organic Chemistry.

To each lecture or recitation one hour is devoted. Mineral-

ogy, which is taught partly by oral methods but chiefly through determinative work in the laboratory, covers two-hour periods. The afternoon periods, given to laboratory, drawing and field-work, are of three hours' duration. The work in Practical Ore Dressing consumes all of the Mondays assigned to it.

SPECIAL COURSES.

In addition to the four complete courses mentioned above a number of shorter courses are also offered, on the satisfactory completion of which students are awarded Certificates of Proficiency.

These embrace an Academic course and special courses in Chemistry and Assaying, Mining, Surveying and Electricity.

They have been planned for the benefit of those who for various legitimate reasons are unable to take the regular four year courses.

The Academic Course is maintained in compliance with an Act of Legislature, session of 1885 (see page 8).

The Academic Department offers a course leading to the degree of Bachelor of Science in General Science, which is outlined on page 28 *et seq.*, but for the next year a shorter Academic Course, which is outlined on pages 30 and 31, will be continued, for the benefit of those who have already entered upon it. In this course English, History, Political Economy, Logic, Mathematics, German, French, and Natural Sciences are offered.

A Diploma of Graduation will be conferred on students completing this course within the next year.

The course in *Assaying* and *Technical Analysis* will require two years' work, although mature students, who have already some knowledge of Chemistry, may complete it in one year. For description see page 31.

The purpose of the course in *Surveying* is to turn out competent land and mining surveyors and fair draughtsmen. The essentials of it are a thorough knowledge of Algebra, Geometry, Trigonometry and Surveying, Field Practice and Drawing. One year and the first term of a second, that is, until the Christmas

recess, will be required for the completion of this course.

A special course in *Mining* is offered to students, especially such as have had some practical experience, who may wish to fit themselves for holding important positions about mines or in ore-dressing plants, but who are unable, on account of the lack of preparation or of time, to take the full course in Mining Engineering. Besides Mathematics this course embraces Elementary Chemistry, Assaying, Mineralogy, Geology, Mining, Surveying, English, Etc. It is a two years' course.

A course in *Electricity* is offered to furnish the student with the theory of electricity, and acquaint him with its applications in the arts. This subject is of prime importance to every engineer, especially to the Mining Engineer, since electricity has become such an important factor in mining operations. For description see page 33.

See remarks on Special students, page 17, and outline of special courses, page 31 et seq.

COURSE I.* MINING ENGINEERING.

FRESHMAN YEAR.

First Term.

Higher Algebra, lectures and recitations	5	hours.
General Chemistry, lectures and recitations	4	"
English, lectures and recitations	5	"
Chemistry, laboratory work	1	afternoon.
Drawing	2	afternoons.
Shop practice	2	"

Second Term.

Trigonometry, lectures and recitations	5	hours.
Geometry, lectures and recitations	5	"
English, lectures and recitations	5	"
Chemistry, laboratory work	1	afternoon.
Drawing	2	afternoons.
Shop practice	2	"

*Time is given in hours or afternoons per week.

Third Term.

Trigonometry, lectures and recitations	4 hours.
Physics, lectures and recitations	5 "
English, lectures and recitations	2 "
French or German	4 "
Chemistry, laboratory work	1 afternoon.
Drawing	2 afternoons.
Shop practice	2 "

SOPHOMORE YEAR.

First Term.

Analytic Geometry, lectures and recitations	5 hours.
Inorganic Chemistry, lectures	4 "
Surveying, lectures	3 "
French or German, lectures	3 "
Chemistry, laboratory work	2 afternoons.
Field Practice in Surveying	3 "

Second Term.

Descriptive Geometry, lectures and recitations	7½ hours.
Calculus, lectures and recitations	2 "
Applied Chemistry, lectures and recitations	5 "
French or German, recitations	3 "
Chemistry, laboratory work	3 afternoons.
Drawing	2 "

Third Term.

Calculus, lectures and recitations	5 hours.
Physics, lectures and recitations	5 "
French or German, recitations	5 "
Chemistry, laboratory work	2 afternoons.
Surveying, field practice	1 afternoon.
Physics, laboratory	2 afternoons.

JUNIOR YEAR.

First Term.

Physics, lectures and recitations	5 hours.
Geology, lectures	3 "
Mineralogy, lectures	4 "
Masonry Construction, lectures and recitations	3 "
Chemistry, quantitative, laboratory work	3 afternoons.
Ore Dressing, class room and laboratory	Saturdays.
Physics, laboratory work	2 afternoons.

Second Term.

Physics, lectures and recitations	2	hours.
Geology, lectures	2	"
Mineralogy, lectures and laboratory	4	"
Mechanics, lectures and recitations	5	"
Dynamo Electrical Machinery, lect. and rec	3	"
Physics, laboratory work	2	afternoons.
Electrical Measurements, laboratory work	3	"

Third Term.

Geology, lectures	3	hours.
Ore Dressing, lectures	3	"
Metallurgy, lectures	4	"
Alternate Current Machinery, lect. and rec	2	"
Stereotomy, lectures and recitations	1	hour.
Ore Dressing, laboratory work		Saturdays.
Drawing	2	afternoons.
Dynamo and Motor Testing, laboratory work	2	"

SENIOR YEAR.

First Term.

Metallurgy, lectures	5	hours.
Electrical Transmission, lectures and recitations	5	"
Frame Structure, lectures and recitations	5	"
Metallurgy, laboratory work		Saturdays.
Metallurgy, designing	1	afternoon.
Electrical Transmission, laboratory	2	afternoons.
Drawing	1	afternoon.

Second Term.

Metallurgy, lectures	5	hours.
Steam Engineering and Power Transmission	5	"
Hydraulics, lectures and recitations	5	"
Designing	4	afternoons.
Thesis	1	afternoon.

Third Term.

Mining, lectures	8	hours.
Metallurgy, laboratory work		Saturdays.
Thesis	5	afternoons.

COURSE II.* CIVIL ENGINEERING.

FRESHMAN YEAR.

Same as in Mining Engineering.

SOPHOMORE YEAR.

Same as in Mining Engineering, except that in third term Civil Engineers take Chemical Laboratory work one afternoon, and Field Practice two afternoons, instead of Chemical Laboratory two afternoons and Field Practice one afternoon.

JUNIOR YEAR.

First Term.

Physics, lectures and recitations	5	hours.
Geology, lectures and recitations	3	"
Masonry Construction, lectures and recitations	2	"
Elective	2	"
Physics, laboratory work	2	afternoons.
Drawing and Field Practice	3	"

Second Term.

Physics, lectures and recitations	2	hours.
Geology, lectures and recitations	2	"
Mineralogy, lectures and recitations	4	"
Mechanics of Engineering, lectures and recit'ns	5	"
Elective	2	"
Physics, laboratory work	2	afternoons.
Drawing	3	"

Third Term.

Geology, lectures and recitations	3	hours.
Mineralogy, lectures and recitations	4	"
Lines of Communication, lectures and recitat'ns	5	"
Stereotomy, lectures and recitations	1	"
Metallurgy, lectures and recitations	4	"
Drawing and Field Practice	5	afternoons.

*Time is given in hours or afternoons per week.

SENIOR YEAR.

First Term.

Frame Structure, lectures and recitations	5 hours.
Astronomy, lectures and recitations	3 "
Elective	5 "
Drawing and Field Practice	3 afternoons.
Elective, laboratory work	2 "

Second Term.

Hydraulics, lectures and recitations	5 hours.
Steam Engineering	5 "
Elective	3 "
Designing and Drawing	2 afternoons.
Elective, laboratory work	1 afternoon.
Thesis work	2 afternoons.

Third Term.

Bridge and Sanitary Engineering, lect. and rec.	3 hours.
Elective	5 "
Designing and Drawing	2 afternoons.
Thesis work	4 "

COURSE III.* CHEMISTRY AND METALLURGY.

FRESHMAN YEAR.

Same as in Mining Engineering, except that German is obligatory.

SOPHOMORE YEAR.

Class room work same as in Mining Engineering, except during the first term Elective 3 is substituted for surveying.

Laboratory Work.

First Term.

Chemistry	3 afternoons.
Drawing	2 "

Lhird Term.

Chemistry	3 afternoons.
Physics	2 "

*Time is given in hours or afternoons per week.

JUNIOR YEAR.

First Term.

Physics, lectures and recitations	5 hours.
Geology, lectures and recitations	3 "
Mineralogy	4 hours.
Masonry Construction, lectures and recitations	3 "
Physics, laboratory work	2 afternoons.
Chemistry, laboratory work	2 "
Ore Dressing	Saturdays.

Second Term.

Physics, lectures and recitations	2 hours.
Geology, lectures and recitations	2 "
Mineralogy, lectures and laboratory	4 "
Theoretical Chemistry	5 "
Elective	2 "
Physics, laboratory work	2 afternoons.
Chemistry, laboratory work	3 "

Third Term.

A. Geology	Either A and B, or C.	3 hours.
B. Stereotomy		1 "
C. Theoretical Chemistry		5 "
Ore Dressing, lectures and recitations		3 "
Metallurgy, lectures and recitations		4 "
Chemistry, laboratory work		4 afternoons.
Ore Dressing, laboratory work		Saturdays.
Stereotomy, for students electing A and B		1 afternoon.

SENIOR YEAR.

First Term.

Metallurgy, lectures and recitations	5 hours.
Thermodynamics, lectures and recitations	2 "
*Organic Chemistry, lectures and recitations	3 "
Elective	3 "
Metallurgy, laboratory work	Saturdays.
Chemistry, laboratory work	2 afternoons.
Designing	2 "

*Students specializing in Metallurgy will be allowed to substitute for this course elective work equivalent in amount, if approved by the Faculty.

Second Term.

Metallurgy, lectures and recitations	5	hours.
Electro-Metallurgy, lectures and recitations	3	"
*Organic Chemistry, lectures and recitations	2	"
Elective	3	"
Electro-Metallurgy, laboratory work	3	afternoons.
Chemistry, laboratory work	2	"

Third Term.

*Organic Chemistry, lectures and recitations	4	hours.
Metallurgical Problems	2	"
Elective	3	"
Metallurgy, laboratory work		Saturdays.
Chemistry, laboratory work and thesis	5	afternoons.

ACADEMIC DEPARTMENT,

with Electives from the courses in Engineering.

COURSE IV.† GENERAL SCIENCE.‡

FRESHMAN YEAR.

First Term.

English Composition, Course I	5	hours.
Algebra	5	"
Geometry	5	"
Chemistry	4	"
Chemistry, laboratory work	1	afternoon.
Drawing	1	"

Second Term.

English, Course I	5	hours.
Algebra	5	"
Geometry	5	"
Physiology	5	"
Chemistry, laboratory work	1	afternoon.
Drawing	1	"

*Students specializing in Metallurgy will be allowed to substitute for this course Elective work equivalent in amount, if approved by the Faculty.

†Time is given in hours or afternoons per week.

‡At least thirteen hours per week (class room work) are required throughout this course.

Third Term.

Trigonometry	5	hours.
Algebra	5	"
Physics	5	"
German or French	4	"
Chemistry, laboratory work	1	afternoon.
Drawing	1	"

SOPHOMORE YEAR.

First Term.

Analytic Geometry	5	hours.
English	3	"
French or German	3	"
Inorganic Chemistry	4	"
Chemistry, laboratory work	2	afternoons.
Elective	3	"

Second Term.

Calculus	2	hours.
French or German	3	"
Elective	5	"
English	5	"
Elective, drawing or laboratory work	5	afternoons.

Third Term.

Calculus	5	hours.
Physics	5	"
French or German	5	"
English	2	"
Physics, laboratory work	2	afternoons.
Elective, drawing or laboratory work	3	"

JUNIOR YEAR.

First Term.

Physics	5	hours.
Elective	8	"
Physics, laboratory work	1	afternoon.
Elective	4	afternoons.

Electives:

Logic	2	hours.
Surveying	3	"
French or German	2	"

Geology	3 hours.
Mineralogy	2 "
Astronomy	3 "
Biology	3 "
Physical Geography	5 "
English History	5 "
General History	5 "
Masonry Construction	3 "

Second Term.

Physics	2 hours.
Elective	10 "
Physics, laboratory work	1 afternoon.
Elective	4 afternoons.

Electives:

Descriptive Geometry	5 hours.
Dynamo Electric Machinery	2 "
Mechanics	5 "
Theoretical Chemistry	5 "
Biology	3 "
Mineralogy	4 "
Geology	2 "
Physical Geography	5 "

Third Term.

Elective	13 hours.
Elective	5 afternoons.

Electives:

Metallurgy	4 hours.
Alternate Current Machinery	2 "
Ore Dressing	3 "
Stereotomy	1 hour.
Theoretical Chemistry	5 hours.
Geology	3 "
Physical Geography	5 "

SENIOR YEAR.

All Elective.

ACADEMIC COURSE.*

To Be Continued Until June 1900 Only.

FIRST YEAR.

First Term.

Elementary Algebra	5 hours.
English—Course I	5 "
General History	5 "
Physiology	5 "

Second Term.

Elementary Algebra	5 hours.
English—Course I.	5 "
General History	5 "
Physical Geography	5 "

Third Term.

Elementary Algebra	5 hours.
English—Course I	5 "
General History	5 "
Physical Geography	5 "

SECOND YEAR.

First Term.

Geometry	5 hours.
Zoology	5 "
French or German	3 "
English History	5 "

Second Term.

Geometry	5 hours.
English—Course II	5 "
French or German	3 "
English History	3 "

Third Term.

Physics	5 hours.
English—Course II	5 "
French or German	5 "
Psychology	3 "

*Time is given in hours or afternoons per week.

THIRD YEAR.

First Term.

Higher Algebra	5	hours.
French or German	5	"
Elementary Chemistry	4	"
Political Economy	5	"

Second Term.

Higher Algebra	5	hours.
Logic	5	"
Elective	5	"

Third Term.

Trigonometry	5	hours.
Civil Government	5	"
Book-keeping (optional)	3	"
Elective	5	"

SPECIAL COURSE IN CHEMISTRY AND ASSAYING.*

FIRST YEAR.

First Term.

English	5	hours.
Algebra	5	"
Chemistry	3	"
Chemistry, laboratory work	3	afternoons.
Elective	2	"

Second Term.

English	5	hours.
Algebra	5	"
Elective	3	"
Chemistry, laboratory work	3	afternoons.
Elective	2	"

Third Term.

Physics	5	hours.
English	2	"
Algebra	5	"
Chemistry	3	"
Elective	2	"

SECOND YEAR.

First Term.

Chemistry	4 hours.
Mineralogy	4 "
Geology	3 "
Chemistry and Assaying, laboratory work	4 afternoons.
Ore Dressing	Saturdays.

Second Term.

Applied Chemistry	5 hours.
Mineralogy	4 "
Geology	2 "
Elective	2 "
Chemistry and Assaying, laboratory work	5 afternoons.

Third Term.

Ore Dressing	3 hours.
Geology	3 "
Elective	5 "
Chemistry and Assaying, laboratory work	4 afternoons.
Ore Dressing	Saturdays.

SPECIAL COURSE IN MINING.*

FIRST YEAR.

First Term.

Algebra	5 hours.
Geometry	5 "
English	3 "
General Chemistry	4 "
Chemistry, laboratory work	1 afternoon.
Drawing	2 afternoons.
Shop practice	2 "

Second Term.

Algebra	5 hours.
Geometry	5 "
Trigonometry	5 "
Chemistry, laboratory work	1 afternoon.
Drawing	2 afternoons.
Shop practice	2 "

*Time is given in hours or afternoons per week.

Third Term.

Algebra	5 hours.
Trigonometry	5 "
English or Physics	5 "
Chemistry, laboratory work	1 afternoon.
Drawing	2 afternoons.
Shop practice	2 "

SECOND YEAR.

First Term.

Surveying	4 hours.
Organic Chemistry	3 "
Geology	3 "
Mineralogy	4 "
Field practice	3 afternoons.
Chemistry, laboratory work	1 afternoon.
Ore Dressing	Saturdays.

Second Term.

Geology	2 hours.
Mineralogy	4 "
Mining	4 "
Chemistry, laboratory work and assaying	5 afternoons.

Third Term.

Geology	3 hours.
Mining	4 "
Ore Dressing	3 "
Metallurgy, elective	4 "
Ore Dressing, laboratory work	Saturdays.
Elective	5 afternoons.

SPECIAL COURSE IN ELECTRICITY.*

FIRST YEAR.

First Term.

Algebra	5 hours.
Geometry	5 "
English	5 "
Chemistry	4 "
Chemistry, laboratory work	1 afternoon.
Drawing	2 afternoons.
Shop work	2 "

†Time is given in hours or afternoons per week.

Second Term.

English	5	hours.
Geometry	5	"
Trigonometry	5	"
Chemistry, laboratory work	1	afternoon.
Drawing	2	afternoons.
Shop Work	2	"

Third Term.

English	2	hours.
Physics	5	"
Elective	5	"
Chemistry, laboratory work	1	afternoon.
Physics, laboratory "	2	afternoons.
Drawing or shop work	2	"

SECOND YEAR.

First Term.

Inorganic Chemistry	4	hours.
Electricity and Magnetism	3	"
Analytical Geometry	5	"
Chemistry, laboratory work	2	afternoons.
Physics, laboratory "	3	"

Second Term.

Electricity and Magnetism	3	hours.
Calculus	2	"
Dynamo Electric Machinery	3	"
Elective	5	"
Chemistry, laboratory work	2	afternoons.
Physics, " "	3	"

Third Term.

Calculus	5	hours.
Physics	5	"
Alternate Current Machinery	2	"
Drawing	2	afternoons.
Physics, laboratory work	3	"

SPECIAL COURSE IN SURVEYING.*

FIRST YEAR.

First Term.

Algebra	5	hours.
English	5	"
Geometry	5	"
Drawing	2	afternoons.
Elective	2	"

Second Term.

Trigonometry	5	hours.
Algebra	5	"
Geometry	5	"
Drawing	2	afternoons.
Elective	2	"

Third Term.

Algebra	5	hours.
English	5	"
Elective	5	"
Drawing	2	afternoons.
Elective	2	"

SECOND YEAR.

First Term.

Surveying	3	hours.
Masonry Construction	3	"
Field Practice	3	afternoons.
Drawing	2	"

DEPARTMENT OF MATHEMATICS.

PROF. DEAN.

Mathematics, on account of its importance as a disciplinary study and its wide application in the practical affairs of life, occupies a prominent position in all courses of study.

*Time is given in hours or afternoons per week.

The methods of the department are neither stereotyped nor mechanical, but every opportunity is afforded for the development of the powers and the individuality of each student.

The study of Mathematics as pursued at this school, is chiefly for the purpose of acquiring a working knowledge of its use in the subsequent studies of engineering, physics and chemistry, and not merely as a component part of a general education. Great care is accordingly exercised to insure the attainment of skill in practical applications requiring analytical power as well as mere computation. Frequent written reviews test the proficiency of the student.

The work prescribed for all candidates for the Bachelor's degree includes the following: Solid and Spherical Geometry, one term, five hours per week; Higher Algebra, one term, five hours per week; Trigonometry, two terms, five hours per week; Analytic Geometry, one term, five hours per week; Calculus, one term two hours per week, and one term five hours per week. Students who have mastered the prescribed subjects may elect courses from the following: Advanced Analytical Geometry, Advanced Calculus, Differential Equations, Harmonic Functions, Quaternions, Modern Algebra, Modern Geometry, Analytic Mechanics, Theory of Functions.

DESCRIPTION OF COURSES.

PRESCRIBED WORK.

1. *Solid and Spherical Geometry.*—Winter term, five hours per week. The class takes a rapid review of the principal theorems of Plane Geometry, spending not more than one week thereon. The course laid down in Phillips and Fisher's Elements of Geometry is closely followed. Numerous original exercises are solved.

2. *Higher Algebra.*—Fall term, five hours per week. At the outset the class will review radicals and quadratic equations. Thereafter the course will include theory of exponents, surds, imaginaries, binomial theorem, convergency and divergency of series, development of functions in series, determinants, theory

of equations and graphic algebra. Hall and Knight's Algebra is used as a text-book. Some portions are omitted and lectures substituted. The course in graphic algebra is given in lectures and notes.

3. *Trigonometry.*—Plane, Spherical and Analytical.—Winter and Spring term, five hours per week.

Crockett's Trigonometry is followed closely so far as solution of triangles and the use of tables are concerned. The course in analytical trigonometry is designed as a continuation of the course in higher algebra, and as a preparation for analytic geometry and calculus. The use of trigonometric functions as analytical instruments, and not as mere formulæ for the solution of triangles, is insisted upon. Numerous exercises aiming to develop analytical powers and skill in computation are a prominent feature of this work.

4. *Analytic Geometry.*—Plane and Solid.—Fall term, five hours per week.

The course in curve tracing having been given in connection with higher algebra and analytical trigonometry, the student at once proceeds to the interpretation of equations, the study and classification of loci, and their applications in geometry and analysis. The determination of empirical formulæ from data furnished by experiment is a part of the course. Tanner and Allen's Analytic Geometry is followed very closely.

5. *Calculus.*—Differential and Integral.—Winter term, two hours per week, and Spring term, five hours per week.

The subjects of Differential and Integral Calculus are carried on together, instead of, as is usual, completing the Differential before passing to the Integral. The utility of the processes called differentiation and integration is indicated from the outset. Care is taken that the student shall understand the nature and properties of the derivative, rather than load his memory with formulæ. The subject is taught, as far as possible, through simple applications to problems in which the student has an interest.

The simpler forms of the differential equations of mechanics and physics are studied as part of the course in Integral Calculus.

Hall's Differential and Integral Calculus is used as a text-

book. Explanatory lectures and notes are given wherever it seems necessary.

DEPARTMENT OF CHEMISTRY.

PROF. ALLEN AND MR. CLARK.

The following work is given:

1. *General Chemistry.*—Four hours of class-room work per week for two terms. Laboratory work one hour per week for one year. The experiments are mostly quantitative, and are intended to teach from the first stoichiometrical relations.

a. First half. (Freshman Year, 1st term.) Fundamental principles, the Chemistry of a few typical elements.

b. Second half. (Sophomore Year, 1st term.) A comprehensive study of the more important elements. Especial attention is given to the Chemistry of the metals. The Periodic Law is followed throughout.

2. *Inorganic Preparations.*—Two afternoons per week, one term. Laboratory work accompanying General Chemistry. Preparation of salts, bases and acids in pure form and by economical methods.

Text-book. Thorpe's Inorganic Preparations.

3. *Qualitative Analysis.*—The equivalent of three afternoons per week for all terms in all courses.

Chiefly laboratory work, though a number of lectures are given, and quizzes are held from time to time.

4. *Quantitative Analysis.*—The equivalent of three afternoons per week for one year in the M. E. Course, and four afternoons in the C. and M. Course.

The first term's work is planned more especially to teach exactness, though the problems are all such as would be met with in practical work. The important acids are determined. Then follow determinations of calcium, magnesium, aluminum, and the analysis of iron, zinc, lead and copper ores. A part of the last term is given to the fire-assay of gold, silyer and lead, and the analysis of fuels.

Students of the C. and M. Course devote the last term of the Junior Year to Water Analysis, Gas Analysis, etc.

Text-books.—Fresenius, Furman. (Standard works of reference are to be found in the laboratory, and are at the disposal of the student.)

5. *Applied Chemistry.*—Five hours per week during the second term of the Sophomore Year.

A course of lectures treating the chemical principles involved in the following subjects:

(a.) Sanitary Chemistry.

The Atmosphere, Air Analysis, as related to Ventilation, Disinfection, Natural Waters, Water Analysis, Water Supply, Sewage and Sewage Disposal.

(b.) Industrial Chemistry.

Fuels, Illuminants, Refractory Materials, Building Materials, Wood Preservatives, Paints, Varnishes, Explosives, etc. The aim is to treat those subjects most likely to be needed by engineers in their practice. Students are required to make a report on some chemical plant, industry or the like, as a result of summer observation and study. No text is used.

6. *Theoretical Chemistry.*—Five hours, second and third terms, Junior Year, for students in the C. and M. Course. The lectures deal with present theories of Chemistry, and their development, as follows:

Beginnings of Quantitative Work, Laws of Chemical Combination, Atomic Theory, Avogadro's Law, Molecular and Atomic Weights, Interrelations of Atoms, Periodic Law, Constitution of the Molecule, Stereo-Chemistry, Solutions, Chemical Reactions, Equilibrium of Chemical Systems, Reaction Velocity, Thermo-Chemistry.

The sources are the recognized authorities in each department of the subject—Kopp, Hoefer, Wurtz, Ernst von Meyer, Lothar Meyer, Muir, Ostwald, Nernst, Mendelejeff.

No text-book was used in 1896-7.

7. *Technical Analysis and Assaying.*—One year, four afternoons per week. This embraces especially fire assaying for gold, silver and lead ores and commercial methods for iron, zinc, lead and copper ores, and furnace products.

Students must have a knowledge of General Chemistry and Qualitative Analysis before taking this work. An Assayer's certificate is given to students who satisfactorily complete Courses 1, 2, 4 and 6.

8. *Organic Chemistry.*—Students in Course III take this subject four hours a week in the third term of the Junior Year, and three hours and two hours respectively in the first and second terms of the Senior Year.

The lectures are accompanied by laboratory work in Organic Synthesis.

DEPARTMENT OF PHYSICS.

PROF. TIMMERMAN. MR. TERRELL.

1. *Elementary Physics.*—Some acquaintance with Elementary Physics is required for entrance, but a more extended and thorough knowledge of the elements is given, as an introduction to the work of the Sophomore and Junior years. The fundamental principles of Physics are discussed as fully as the time allotted will permit. The work is carried on by lecture and recitation; the lectures are illustrated by simple experiments. (Freshman, third term, five times a week.)

Text-book.—Elements of Physics, by Carhart and Chute.

2. *Electricity and Magnetism.*—Lectures and recitations three hours a week during the first term. This course is designed as an introduction to the study of Electricity and Magnetism. Open to all who have completed 1.

Text-book.—Lessons in Electricity and Magnetism, by S. P. Thompson.

3. *Practical Electricity.*—Lectures and recitations three hours a week during the second term. The work during this term deals with the principles underlying the construction of dynamos and motors. Open to all who have completed 1 and 2.

Text-book.—Slingo and Brooker's Electrical Engineering.

4. *Laboratory Work in Electricity and Magnetism.*—Two afternoons a week throughout the year.

5. *General Physics.*—The study of advanced physics is taken up during the third term of the Sophomore year, and continued during the first and second terms of the Junior. The Sophomores study Kinematics, Statics, Kinetics, and the Mechanics of Fluids during the first part of the term, and conclude with the subject of Heat toward the last of the term. The study of Heat includes an introduction Thermodynamics. Particular attention is paid to harmonic motion as the basis for the study of the subjects of Sound, Light and Alternating Currents of Electricity. (Five times a week during the third term.)

During the first term ot the Junior the study of Electricity and Magnetism is taken up. This includes such subjects as: current, potential, quantity, capacity, resistance, self-induction, mutual-induction, magnetism, electro-magnetism, the dynamo, motor, etc., static electrification, electric waves, etc. Lectures and recitations five times a week during the first term.

Two hours a week during the second term Junior are spent in the study of Sound and Light. The course in Light includes reflection, refraction, diffraction, interference, polarization, etc. Twice a week during the second term.

The work is carried on by lecture and recitation. The lectures are illustrated by experiments. The method of the calculus is employed throughout.

At the end of the course several lectures on the Electro-Magnetic Theory of Light are given.

Text-book.—The Elements of Physics, by Nichols and Franklin.

6. *Laboratory Work in Mechanics, Sound, Light, Heat, Electricity and Magnetism.*—In the laboratory, the work is quantitative and aims as far as possible to instruct the student in the methods of physical measurement and the derivation of relations between the quantities measured. Emphasis is laid upon the derivation of physical laws rather than the verification of them. Required of Sophomores two afternoons a week during the third term, and of Juniors two afternoons a week during the first and second terms.

7. a. *Dynamo Machinery.*—During the second term the Juniors in Mining Engineering meet three times a week for dis-

cussion of direct current dynamos and motors. This course includes a discussion of the magnetic circuit of dynamos and motors, with methods of connecting for operation in series and parallel; characteristic curves, methods of testing dynamos and motors, etc.

b. *Alternating Current Machinery.*—Alternating currents and alternate current machinery are discussed twice a week during the third term.

c. *Electrical Transmission of Energy.*—The Seniors meet five times a week during the first term for the study of Electrical Transmission. This includes the transmission of energy by direct and alternating currents, including polyphase transmission. The various methods of series and parallel distribution are discussed, including design of conductors for minimum first cost of plant, for maximum economy, etc. Lectures and recitations.

8. *Electro-Metallurgy.*—This course includes a general discussion of solution and electrolysis with their applications in chemistry and metallurgy. The principal methods of transmission are discussed. Three times a week, for five weeks, during the second term. Required of Seniors in the course in Chemistry and Metallurgy. The work is carried on by lecture and recitation.

9. *Thermodynamics.*—A short course, including the application of thermodynamics to chemical and physical processes. Twice a week during first term. Required of Seniors in the course in Chemistry and Metallurgy.

10. *Dynamo Laboratory.*—The work in the Dynamo Laboratory includes calibration of instruments, characteristic curves of dynamos and motors, efficiency tests of dynamos, motors, alternators, transformers, etc. Required of Juniors in Mining Engineering three times a week during the second term, and twice a week during the third term, and of Seniors twice a week during the first term.

11. *Thermodynamics of the Steam Engine and Other Heat Motors.*—This course includes the theoretical discussion of the operation of Steam Engines, Hot-air Engines, and Gas and Gasoline Engines. The compression of air and the transmission of power by compressed air are also discussed. The details of Engines are shown and explained with the aid of lantern slides. Use

of the indicator and methods of testing heat engines are explained. (Five times a week during the second term.)

Text-book. Thermodynamics of the Steam Engine, by C. H. Peabody.

12. *Mechanics of Engineering.*—During the second term a course in Mechanics of Engineering is given. The work includes statics and kinetics with their applications to engineering problems. Such subjects as center of inertia, moment of inertia, work, energy, power, friction, etc., are treated at some length. Required of Juniors in the C. E. and M. E. Courses, five times a week during the second term.

Text-book.—Mechanics of Engineering, by I. P. Church.

Laboratory Text-books.—Stewart and Gee, Vol. I, Elementary Practical Physics, and Vol. II, Electricity and Magnetism; E. L. Nichols, Laboratory Manual, Vol. I and Vol. II; Kohlrausch, Physical Measurements; Carhart and Patterson, Electrical Measurements; Ostwald, Physico-Chemical Measurements.

ELECTIVE WORK.

13. *Theory of Electricity and Maynetism.*—A mathematical treatment of the subject. Three hours a week during the first and second terms. Open to graduates and to advanced undergraduates.

Text-book.—Electricity and Magnetism, by F. E. Nipher.

14. *Alternatiny Currents.*—An analytical and geometrical treatment of the subject. Two hours a week during the first and second terms. Open to graduates and to advanced undergraduates.

15. *Dynamo Desiyn.*—This course includes the design of dynamos, motors, alternators and transformers. Three afternoons during the third term. Open to those who have completed courses 7a and 7b.

DEPARTMENT OF CIVIL ENGINEERING.

PROF. HARRIS, MR. TERRELL AND MR. HATCHETT.

1. *Surveying.*—First the field instruments of the engineer are dissected and studied in every detail—their theory, adjust-

ment and construction, each receiving careful attention. Their uses and capabilities are thoroughly discussed and applied in Field Practice. Every student is required to adjust and use the various instruments until he is familiar with them. Next are studied: Surveys for boundaries, areas and subdivisions of land, including Government subdivisions; city, mine, topographical and hydrographical surveying.

The Field Exercises are selected with the intention of giving as great variety as possible. A complete topographical map, made from notes taken in the field, is required of every student during the Sophomore Year. (Sophomore, first term, three recitations and three afternoons of field practice a week.

2. *Descriptive Geometry.*—Theory of parallel and of central projections as applied to the science of drawing, with daily blackboard exercises in presenting the projections of familiar objects, intersections of plane and curved surfaces, sections, shadows and perspectives. The afternoons in the drawing room are devoted to the solution of more elaborate exercises, completion of the topographical map, and a finished drawing in isometric and perspective. (Sophomore, second term, five recitations and two afternoons of drawing a week.)

Text-book.—Low's Descriptive Geometry.

3. *Masonry Construction.*—This course treats of the economic properties of building stone, brick and cements; the proportioning, mixing and placing of concrete; preparation of foundations, and strength and stability of masonry structures, including heavy buildings, dams, piers, abutments, retaining walls and arches. Each student is required to test, according to standard specifications, several brands of cement, and to analyze and trace the resultant of the forces acting on several important masonry structures. (Junior, first term, three times a week.)

Text-book.—Baker's Masonry Construction.

4. *Lines of Communication.*—This course is devoted to the surveys for railways, highways and canals; the setting out, estimating and execution of earthwork.

In the assigned afternoons the student is drilled in the most satisfactory methods of accomplishing such surveys. Each student is assigned a section in superintendence, of which he must

set out and estimate the earthwork for a railway. In the drawing room he will make maps and profiles of the surveys as set out. Other exercises in draughting will be assigned, as time for their completion is available. (Junior, third term, five lectures and three afternoons of field practice a week.)

5. *Stereotomy.*—The application of Descriptive Geometry to the art of stone-cutting—obtaining the projections, templets and directing instruments for the individual stones in the various forms of structures, and the construction of models in the same.

Text-book. Warren's Stone-Cutting, with lectures.

(Junior, third term, once a week, with afternoon exercises.)

6. *Framed Structures.*—This course, designed alike for students in Mining and Civil Engineering, treats of general methods of determining stresses in such structures as single-span bridges, roof trusses, towers, derricks, etc., and of the design of individual members—post, beams and rods to carry predetermined stresses or loads. The suspended cable tramway receives practical treatment. The student is required to work out the stresses in one structure or more of each kind under a specified loading.

In the afternoons the Senior classmen may be occasionally required to direct and check the field exercises of the Sophomore or Junior classes; otherwise the assigned afternoons will be spent in the solution of problems in graphic statics, working out details in structural iron work, estimation of quantities, weights, etc. (Senior, first term, five times a week with afternoon work.)

7. *Hydraulics.*—The study of practical applications of the laws of hydrostatics, measurement and storage of water, flow through pipes and canals, design of pipe lines, and the theory of the various classes of hydraulic motors.

The afternoons are given to the design of such structures as the student is now competent to understand, and to work a thesis, which should be commenced during this term. (Senior, second term, five times a week, with afternoon work.)

Text-book.—Merriman's Hydraulics.

8. *Prime Movers and Power Transmission.*—The student receives such instruction as is deemed essential to Civil and Mining Engineers. Power transmission by steam, compressed air, cable, and water, are studied theoretically, and details of many plants,

examined as presented in the current engineering journals. (Senior, third term, five times a week.)

9. *Bridge Engineering; Sanitary Engineering.*—Students in Civil Engineering make a more thorough study of bridge construction than is accomplished in the first term. They also make a study of details of water supply and of sewerage of cities. At the same time the student is required to do much reading in the engineering journals, descriptive of recently completed engineering structures, water works and sewerage systems. The assigned afternoons will be given to the preparation of a thesis. (Senior, third term, three times a week, with afternoon work.)

10. *Astronomy.*—Determination of latitude, longitude and time, with reading and lectures in Descriptive Astronomy. (Senior, first term, three times a week. Required only in C. E. Course.)

11. *Shop Work.*—This is intended to familiarize the student with the practice and theory of wood-working as employed in engineering construction. The course consists of a series of graded exercises on the bench and lathe which involve the principles of joining, pattern making and construction. These are followed by the making of parts of engineering structures, or of complete small structures, from detail drawings prepared by the upper class-men in their engineering designs, or by the instructor.

Students are required to make a working drawing of each exercise before its execution in the shop.

(Freshman, twice a week throughout the year.)

12. *Drawing.*—Freshmen devote six hours per week to exercises in ruling, line-shading, etc., calculated to teach the use of drawing instruments, followed by a thorough drill in free-hand lettering, pencil sketching and drawing from models, scaled machine and architectural drawings from detail plates, tracing and blue-printing.

The work of the Sophomores consists of brush-shading in India ink, of plane, cylindrical, spherical, and other surfaces, followed by a graded series of machine drawings. The latter involve, first, making free-hand sketches of the details of machines, such as locomotive parallel rods, piston rods, crossheads, check valves, globe valves, lathe stocks, steam engine cylinders, valves,

etc., with dimensions carefully indicated. From free-hand sketches thus prepared, the student makes the assembled drawing to scale by use of drawing instruments, presenting as many views and sections as are necessary to make the drawing readable.

Considerable time is given to working exercises in Descriptive Geometry, and to preparing plats of surveys made in field practice.

The work outlined above continues throughout the year in connection with the field practice. When students are not called out to field practice they spend their time at regular work in the drawing room.

In the Junior and the Senior years the draughting work is made to accompany and illustrate the class instruction, as outlined above, the work in each course being made to fit its particular needs. In the Senior year much of the draughting is in the execution of designs. These will take the form, for Civil Engineers, of the design of a bridge, roof truss, or other structure; for students in the other courses, of designs of mining machinery or metallurgical appliances, the latter being made under the direction of the Professor of Mining and Metallurgy.

DEPARTMENT OF MINING AND GEOLOGY.

PROF. LADD.

Lectures and laboratory work, supplemented by excursions in the field make up the courses in this department, which are as follows:

1. *Crystallography.* This subject is taught as an introduction to the courses in Mineralogy, and consists of lectures on the general principles of the subject, with a careful study of the forms of the different systems, and the different methods of notation. The study of wooden and transparent models, drawings and natural crystals constitute an important part of the course. (Juniors, first term as a part of Mineralogy.)

2. *Mineralogy.* This course consists of lectures and laboratory work. It involves the study of the most important metal-

liferous and rock-forming minerals. Blow pipe determination is made use of, and the student is taught also, as far as possible, to recognize the minerals through their various characteristics without the use of qualitative analysis and blow-pipe work. Moses' Mineralogy and Blow-pipe Analysis, and Dana's Text-book of Mineralogy may be used as a text. Frazer's Mineral Tables is also made use of. (Junior, first and second term, four hours per week.)

3. *Lithology.* The practical determination of rocks is treated as a continuation of Mineralogy, students being allowed to use either Williams' or Kemp's Handbook of Rocks. (Junior, first term, part of time allotted to Mineralogy.)

4. *General Geology.* This is a lecture course devoted to the principles of general and economic geology. It describes the evolution of the earth, its present condition, and the processes which have modified its crust and surface. Owing to its economic importance special attention is paid to structural geology, and the student is taught to make and to interpret geological maps and sections covering a great variety of faulting and folding of strata. This course is closed with a discussion of the general features of the geology of the United States. (Junior, first term three hours, second term two hours, third term three hours. It is continued through the year by 5.)

5. *Economic Geology.* This is a series of lectures dealing with the occurrence, origin, distribution of ores, clays, building stones, gems, water supply and other products of economic value from the different geological formations. The characteristics and genesis of ore deposits are carefully considered.

6. *Mining.*—Lectures on Prospecting, Drilling and Wellboring, Exploitation, Methods of Extraction, Blasting, Transportation, Drainage, Ventilation, Lighting, Accidents, Hygiene, Mining Law, Sampling and Examination of Mines, and Quarrying, extend through two terms. Practical problems, projects, and reports on visits of inspection, constitute features of the course. (Senior, third term, three hours per week; third term, five hours per week.)

7. *Mine Surveying.*—Some additional matter, such as methods adapted to special cases, with problems involving the princi-

pal conditions encountered in mine surveying, are included in the course in Mining. The subject of Mine surveying constitutes part of the course in Engineering Geodesy in the Department of Engineering. (Junior. Part of Mining).

8. *Mining Design.*—Involves the designing, making out of specifications, and execution of working drawings of hoisting works, mine drainage and ventilation plants, transportation systems, laying out of mines, etc. May constitute a part of Thesis work. (Senior, first and second terms, two afternoons per week).

DEPARTMENT OF METALLURGY AND ORE DRESSING.

PROF. DRAPER.

The work in this department is designed to give students a thorough training in all branches of Metallurgy, and in methods of concentrating and dressing ores.

It is recognized that a school cannot give students, in the brief time at its disposal, that skill which comes from long practice, but it is the aim of the department to give such training in the fundamental principles and their application, that students may become useful immediately on their entrance into the actual practice of their chosen profession.

An important feature of the instruction in this department is original experimental investigation in the concentration and metallurgical treatment of various ores.

Memoirs, reports on visits to metallurgical works, and the solution of problems relating to Metallurgy and Ore Dressing, are given due prominence in the courses.

Work is given as follows:

1. *Metallurgy.*—Beginning with general principles of Metallurgy, including the properties of metals, the metallurgy of alloys, bronzes, brasses, etc., fuels, fluxes and calculations of furnace charges, general study and classification of furnaces. No text-book required. Roberts-Austen's "Introduction to Metallur-

gy" is recommended. (For Juniors in C. E., C. and M., and M. E. courses. Elective course IV).

2. *Metallurgy of Iron and Steel.*—In this course a somewhat careful study is made of the various processes employed in the production of cast iron, wrought iron and steel. Special attention is paid to American practice. The theoretical and descriptive work of the lecture room is supplemented by a metallurgical excursion to a blast furnace and to iron and steel works in the vicinity of St. Louis.

No text-book is required. Turner's Metallurgy of Iron and Steel (Chas. Griffin & Co., Exeter St., Strand, London,) is, however, recommended. (For Juniors in C. E., C. and M., and E. M. Courses. Elective in Course IV).

3. *Non-ferrous Metallurgy.*—Supplements Course 2. Continues with other commercial metals along line of study of iron and steel. As with 2 a metallurgical excursion is conducted for the benefit of students in this course.

No text-book required. Schnabel's "Metallurgy" recommended. (For Seniors in C. and M. and M. E. Courses).

4. *Advanced Work in Metallurgy.*—Problems in design of Metallurgical plants and reports on special processes are assigned to students. All reports are in written form, and will be corrected by the English Department.

5. *Metallurgical Designing.*—Students are required to design plants or furnaces for treatment of ores of different kinds and under different conditions. (Seniors in C. and M. Course).

6. *Metallurgical Laboratory.*—Saturdays during first and third terms are devoted to laboratory work in Metallurgy. This work consists of tests in ores by chlorination, cyaniding, lixiviation, amalgamation in pans, or with stamp battery. The department has also a reverberatory roasting furnace, and a water jacket shaft furnace for lead or copper ores.

7. *Electro-Metallurgy.*—This course completes the work begun by the Physical Department, and consists of lectures and recitations concerning the various processes of obtaining metals or products of economic value by means of the electric current. (Seniors in C. and M. Course three hours per week during second term.)

8. *Ore-Dressing.*—A course of lectures, with practical problems, projects, etc., on the principles, methods and leading mechanical appliances in use to-day for crushing, comminution, classification and concentration of all important ores, together with a thorough treatment of the preparation of coal, magnetic separation as applied to the enrichment and purification of iron ores, and to the elimination of iron from zinc and other ores. (Junior, first term, part of time assigned to laboratory work on Mondays; third term, three hours per week.)

9. *Ore-Dressing Laboratory.*—Saturdays throughout the first and third terms are devoted to work in practical tests in the crushing, classification and concentration of ores. As previously stated a part of this time in the first term is to be used for lectures preparatory to the practical demonstration in the laboratory. The object is to give the student experience in the more common methods of ore dressing treated in the theoretical discussions on this subject, and to afford him practice in the application of the principles learned in the class room to the production of useful results. The laboratory is fitted with crushers, rolls, a stamp battery, hydraulic classifiers, jig, fruevanner, percussion tables, etc. Detailed reports are required on all work done. (Junior, first and third terms, Saturdays.)

MODERN LANGUAGES.

MR. WILKINS.

The great quantity and worth of the technical literature in the French and German languages, added to their value as elements of liberal culture, makes at least a reading knowledge of them a highly desirable part of an engineer's education. German is required in Course III, while the choice of French or German is permitted in Courses I, II and IV.

The instruction in each language is designed to present the grammatical structure and the pronunciation of the tongue, to give some acquaintance with the masterpieces of its literature, and to confer such facility in translation as will enable the student

to read with ease the lanuguage in both its literary and its scientific uses.

German, Freshman Year.—Introductory lessons on pronunciation and German script, Keller's First Year in German. (Four times per week, third term).

German, Sophomore Year.—Van Daell's Reader, Grammar and Composition, Schiller's "William Tell," Lessing's "Nathan der Weise," Goethe's "Hermann und Dorothea," and selections from other German authors.

The students in Scientific German read Hodge's Course in Scientific German. They are also required to do parallel reading in the current scientific magazines and standard scientific works.

French, Freshman Year.—Languellier & Monsanto's Grammar. (Four times per week, third term).

French, Sophomore Year.—Grammar (continued), original exercises, Racine's "Phedre," "Le Roman d'un Jeune Homme Pauvre, (Feuillet), "L'Abbe Constantin" (Halevy), Herdler's Scientific French Reader, Marie's "Historie des Sciences."

Parallel reading, outside of that done in class, will be assigned, and will constitute part of the work on which the student is examined.

Spanish.—The growing demand for mining engineers and metallurgists in South and Central America, and in Mexico, where a knowledge of Spanish is almost an essential qualification, has been met by the establishment of a course in this language in the School of Mines. The natural, or conversational method is followed exclusively, with Ramsey's "Modern Spanish" as a reference grammar.

The object is to give the student not a knowledge of literary Spanish, but facility in the every-day speech of the people.

ENGLISH.

MR. SCOTT.

Rhetoric.—The language an individual uses is taken, more than any other one thing, as an index to his culture, both general and special. The ability to use good English is due largely to

intelligent practice, oral and written. The relation between thought and its expression should be appreciated. That the "flow of thought increases with an ability to express thought" is axiomatic. To a great extent success in other branches depends upon proficiency in this subject, because work in all other courses is facilitated and expedited by the student's trained power of expression. (Five times per week during first and second terms).

Text-book.—Hill's Foundations of Rhetoric.

English Literature.—The two main purposes in the study of this subject are to supplement the work of rhetoric, and to develop a taste for good literature. In the study of any subject illustration is of immeasurable value. It is, in fact, the avenue to the mind, hence examples of the best style enable the pupil to appreciate how thought can be most forcibly and beautifully expressed. As in the natural sciences, by the most approved methods we study *things* and not what some one has said about them, so in literature we study the production of authors, instead of occupying our time wholly with biographies, notes and critiques. The aim in the reading of an author will be the study of the thought and the expression in their reciprocal relations. The writing of essays will be required weekly. The school is splendidly equipped with all references necessary to make this course instructive. (Five times a week during first and second terms).

Text-book.—Pointer's English Literature.

ACADEMIC SUBJECTS.

MESSRS. WILKINS AND SCOTT, AND PROF. DEAN.

English History.—The most important principles of English history from the time of the Anglo-Saxons to the present will be concisely but lucidly discussed. (Five times a week during first and second terms). Mr. Scott.

Text-book.—Green's Short History of the English People.

Political Economy.—All that is attempted in this subject is to present in a plain and simple form the elementary principles of political economy. The main topics are treated, and the fundamental principles studied and discussed, but no attempt will be

made to inculcate any particular economic doctrine. (Five hours a week during the first term). Mr. Scott.

Text-book.—Laughlin's Elements of Political Economy.

General History.—This subject is important and difficult, requiring not only a constant and vigorous exercise of the memory, but careful thinking, that the pupil may have a clear conception of the course and relation of events. The teacher and student often treat history as a mere study of the record of the times, persons, places and events on which wars play the most conspicuous part, thus forgetting that chief attention should be given to causes and effects in national growth or change. Great pains will be taken by outside reading and illustration to make historical accounts realistic. Our library furnishes all necessary books of reference. (Five times a week throughout the year). Mr. Scott.

Text-book.—Myer's General History.

Mathematics.—A thorough knowledge of Elementary Algebra and Geometry is an essential requisite of a general education, as well as for entrance into higher scientific courses. During the first year students take Elementary Algebra, beginning with the fundamental operations and completing Quadratic Equations and the Progressions. In the second year they have a thorough course in Elementary Geometry, Plane and Solid, with much practice in problem solving. In the third year they have a course in higher Algebra, including the study of Series, Indeterminate Coefficients, Logarithms, Theory of Equations, Determinants, etc., and complete Plane Trigonometry. Prof. Dean.

Text-books.—Hall and Knight's Algebra, Phillip's and Fisher's Plane and Solid Geometry, Well's Trigonometry.

Physics.—See "Elementary Physics", page 40.

Chemistry.—See "General Chemistry," page 38.

English.—See page 52.

French or German.—Students completing the Academic Course are required to take four terms of French or German. For information concerning these subjects see Modern Languages, pages 51 and 52.

Psychology.—As psychology is the only branch that gives us information concerning mental processes involved in knowing, any one concerned about the development of himself, the educa-

tion of his own children, or those of others, should be deeply interested in this subject. The end to be reached in teaching this branch is to acquaint the student with some of the important principles of mind development. (Five hours each week during the third term). Mr. Scott.

Text-book.—Roare's Psychology.

Logic.—As it is the main business of every one to think correctly it is important that we should acquaint ourselves with the laws of thought as presented in logic. The aim will be to familiarize the pupil with the fundamental principles of reasoning, and to employ such methods in the effort to do so as will make the student a consciously correct reasoner. (Five hours a week during the third term). Mr. Scott.

Text-book.—Hill's Jevon's Logic.

Physical Geography.—The comprehensive nature of this study does not admit of its being treated in all its phases in the short time allotted to it.

The course will be principally descriptive, though the presentation of the scientific principles involved will be as thorough and complete as practicable, the design being to make this study serve as an introduction to the other natural sciences taken up later in the course. (Five hours a week during second and third terms).

Text-book.—Appleton's Physical Geography. Mr. Wilkins.

Physiology.—It is aimed to make the instruction in this branch as thorough and practical as possible, and to lead the student to obey the injunction "Know Thyself." (Three hours a week during second term). Mr. Wilkins.

Text-book.—Martin's Human Body.

GENERAL INFORMATION.

TERMS AND VACATIONS.

The college year, consisting of 38 weeks, exclusive of the Christmas holidays, is divided into three terms; the first beginning September 19th, and ending with the Christmas holidays; the second beginning with the first Tuesday in January (the 2nd), and extending to the 17th of March, and the third beginning on

the 19th of March and closing Commencement Day, June 13th. The Christmas holidays cover ten days and intervene between the first and the second term. There is no interruption of work between the second and the third term. Thanksgiving Day and Washington's Birthday are observed as single holidays. In the month of April there occurs a variation of work which may be regarded as a partial holiday. A week is set aside in which there are no recitations, but students devote themselves to consecutive work in the various laboratories, the drawing-room, or the shop; to field excursions for practice in engineering or geology; or to visits of inspection to mines and metallurgical works. The precise date is left to be determined later so that if possible a period may be chosen when the weather is suitable for out-door work.

During the past year the students of the Senior Class made an excursion to St. Louis and to the southeastern part of Missouri. At St. Louis the methods of smelting zinc ores, of smelting and refining lead ores when accompanied by silver, and of the manufacture of steel by the basic open hearth process, were studied. In the lead producing region of southeastern Missouri, the mines and mill of the St. Joseph Lead Company, at Bonne Terre, of the Desloge Lead Co., at Desloge, and of the Central Lead Co., at Flat River, were visited, where a careful study was made of the methods of concentration of galena ores by both the English and Continental systems. The students in Mining Engineering were also enabled to make a careful study of the methods of mining. The roasting and reduction of lead ores and refining of the bullion were seen at Herculaneum, as well as the places mentioned above.

The classes in Civil Engineering spent their time in triangulation and topographical reconnoissance.

The other students were occupied in the drawing rooms, shops and laboratories.

EXPENSES.

Laboratory Fees.—The Board of Curators at a meeting held in December, 1898, voted to make *tuition free*, and to abolish the entrance fees which have hitherto been charged. The only fixed charges remaining are: a library fee of $5 per year, payable upon

entrance; a laboratory fee to cover the cost of gas and supplies, amounting to $8.50, for the Course in General Chemistry; a laboratory fee of $12.50 to cover the cost of general supplies, gas, etc., for the course in Qualitative Analysis; a fee for seniors and juniors, taking chemical laboratory work, of $3.50; a fee for the course in Shop Work, to cover the cost of supplies, of $2.00; a general fee, to cover the cost of supplies, to students taking Assaying, of $20; and a fee, for students taking Mineralogy, to cover the cost of supplies, of $5.

The above charges are made on the basis of the actual average cost per student for supplies in the respective courses, at wholesale rates.

Contingent Deposits.—Deposits, to cover the cost of extra supplies, damage to apparatus, etc., are required of the different classmen, as follows: Freshmen, $5; Sophomores, Juniors and Seniors, $10. These deposits must be renewed if at any time exhausted, and at the end of the session whatever sum may remain to the credit of the depositor is returned to him.

No distinction, in admission or charges, is made between residents of this State and those of any other States or countries.

The cost of living in Rolla is low. Board, including lodging, meals, fuel and lighting, may be had in private residences for from $11.50 to $17.00 per month, and at the hotels for from $15.00 to $20.00 per month. Washing costs from $1.00 to $1.50 per month.

The expense of many students for the entire school year does not exceed $150.00; and $225.00 will cover, in a liberal manner, the fees, and the cost of books, stationery, board, lodging, fuel, lights and washing.

SOCIETIES.

A number of societies have been organized and are maintained by the students. Among these are the Literary Club, which meets fortnightly, and the so-called "Engineering Club," which is at present composed of students in Chemistry, and which devotes itself to the critical study of technical articles in the various publications relating to Chemistry, with which the Library is supplied.

A branch of the College Young Men's Christian Association

has been organized and is in a flourishing condition. It has at present very comfortable quarters in the Club House or Dormitory. The society has a pleasant reading room with a piano, and has also a gymnasium well equipped with apparatus.

Mr. Geo. L. Olmstead, President of the Society, will be glad to answer letters of inquiry or to help prospective students in any way, engaging rooms and board, or rendering any service of like nature.

ATHLETICS.

The School encourages rational athletics. Occasional privileges are granted to athletic teams, but prolonged absences from work are not permitted.

An athletic field has been enclosed and graded for baseball, football, etc., and an ample number of tennis courts have been laid out, and are maintained in good order. A general athletic association exists among the students, also football and baseball teams, and a tennis club. A good gymnasium, referred to above, is maintained by the Y. M. C. A. Society.

ALUMNI ASSOCIATION.

The Association of Alumni of the School of Mines has the following officers: Dr. Floyd Davis, of Des Moines, Iowa, President; Mrs. Cornelius Roach, of Carthage, Mo., Vice-President, and Prof. George R. Dean, of Rolla, Mo., Secretary.

The wide dispersion during the last few years of the graduates of the School, (who are scattered from Boston to San Francisco, and from Alaska to Tehuantepec, with representatives in South America and South Africa,) renders their assemblage difficult. It is intended, however, that at each commencement as many as possible shall meet in Rolla to renew associations with each other and with their Alma Mater.

EXAMINATION OF MINERAL SPECIMENS.

The School receives a great many inquiries concerning the examination of specimens, and it is deemed advisable to state in the catalogue its usage in this matter. The School desires to aid the miners and prospectors of the state, has aided and is aiding them. If, however, it were announced that all specimens sent in would be analyzed free of charge, there would be a deluge of rocks, usually worthless, that would consume all the time of officers whose chief duty is instruction. Hence, the following rule is adopted: Of any specimen found on Missouri soil, and sent, carriage paid, the School will make, free of charge, such preliminary examination as shall be sufficient to disclose its character, and whether or not it possesses probable value. The sender is informed of the result and whether an assay seems advisable. If he chooses to have an assay made, a small fee—usually $1.50 per assay—is charged.

DEGREES.

On Commencement Day, June 8, 1898, the faculty awarded the following :

Civil Engineer,

HERMAN CYRIL COWEN.

Bachelor of Science, (Civil Engineering).

ARTHUR DAVIS TERRELL. EUART CARL TORRENCE.

Bachelor of Science (Mine Engineering).

RALPH BARKER.

Bachelor of Science (Chemistry and Metallurgy.)

VICTOR HUGO GOTTSCHALK.

DIPLOMAS OF GRADUATION.

Mathematics.

MISS SARAH BEALL. FREDERICK RAGLAND COWLES.

Academic Department.

RULOF THEODORE ROLUFS.

CERTIFICATES OF PROFICIENCY.

Mathematics,

FRANCIS JOSEPH TAYMAN.

Surveying,

FRANCIS JOSEPH TAYMAN. HERBERT FORDYCE ROGERS.

Assaying and Technical Analysis.

LOUIS JOHN CHAMBERLAIN.

STUDENTS.

GRADUATES.

Barker, Ralph.....Chicago, Ill.
Budrow, Lester R.....Zacatecas, Mexico.
Buskett, Evans.....Rolla, Mo.
Dean, George W .....Elk Prairie, Mo.
Herdman, George W.....Rolla, Mo.
Ross, Beauregard.....Cameron, Mo.
Terrell, Arthur D .....Holden, Mo.

SENIORS.

Bierbaum, Edward Charles.....Monoma, Ia.
Clark, George Clough.....Leadville, Col.
Hatchett, Roger Hanson.....New Florence, Mo.
Hendricks, James Otto.....Bolivar, Mo.
Perkins, Fred Hough.....Kansas City, Mo.
Perkins, Edwin Thompson .....Kansas City, Mo.
Rogers, Herbert Fordycell .....Holden, Mo.
Soest, Walter Ernest .....Phelps County, Mo.
Schulze, Herman Otto.....Vetschua, Germany.
Tayman, Francis Joseph.....Lebanon, Mo.
Taylor, Joshua Howard .....Abbingdon, Ill.
Underwood, Jerrold Ros.....Kansas City, Mo.

JUNIORS.

Barber, Frank Sturns.....Kansas City, Mo.
Chamberlain, Santiago.....Monterey, Mex.
Creveling, DeWitt.....Clayton, Mo.
Coffer, Robert Henry.....Savannah, Mo.
Connor, Naisi Ainli.....New York City.
Drennan, Ralph W. W.....Kansas City, Mo.
Fach, Charles Albert.....St. Louis, Mo.
Fraizer, Isaac Peter.....Rolla, Mo.
Fernandez, Abraham.....Monterey, Mex.
Garcia, John Adrian.....St. Louis, Mo.
Jamison, Claude Egan.....Rolla, Mo.
Leivy, Benj. Pasha.....East St. Louis, Ill.
Lund, Albert E.....White Oaks, N. Mex.
Rolufs, Rulof Theo.....Newburg, Mo.
Seifert, Charles George.....Joplin, Mo.
Villareal, Francisco.....Monterey, Mex.
Weigel, William Melvin.....Memphis, Tenn.

SOPHOMORES.

Buckby, DeNard Wilson.....Philadelphia, Pa.

Brucher, Louis..... Rolla, Mo.
Draper, James C .....Lebanon, Mo.
Donahoe, Daniel Francis .....Rolla, Mo.
Fitz, John C. H.....Lynn, Mass.
Garrett, L. Ellis.....Maryville, Mo.
Gonzalez, Edwardo P..... .....Monterey, Mex.
Hannah, Harry Dalton.....Greenton, Mo.
Hanley, Herbert R.....Chicago, Ill.
Higgins, Louis L.....Leeton, Mo.
Luther, Walter R..... .....St. James, Mo.
Martinez, Carlos E.....Saltillo, Mex.
Mortland, Ernest A..... .....Hardin, Ill.
Olmstead, George L.....Kansas City, Mo.
Powell, Walbridge J..... .....Rolla, Mo.
Reid, John Weir ....Memphis, Tenn.
Stauber, Ignatius H..... .....Brookville, Kas.
Southgate, John McKnight.....Rolla, Mo.
Watkins, James T.....Ennis, Tex.
Wallace, Hubbe R.....Webb City, Mo.
Wallace, Charles.....Lebanon, Mo.
Weidner, Frank.....Dixon, Mo.
Wilson, A. Dyke.....Kansas City, Mo.

FRESHMEN.

Brown, Bruce H.....Troy, Ill.
Cale, DuTro C. .....St. Louis, Mo.
Case, William R .....Lebanon, Mo.
Carpenter, R. W .....St. James, Mo.
Cox, Katherine.....Rolla, Mo.
Faulkner, Robert T.....Rolla, Mo.
Faulkner, James Porter .....Rolla, Mo.
Grover, Frank S..... ...Cuba, Mo.
Hall, John L.....Freuta, Col.
Keene, Walter McA..... .....Denver, Colo.
Macklind, Thomas.....St. Louis, Mo.
McMahon, William.....Butte, Mont.
McTighe, Claude M.....Memphis, Tenn.
McTighe, Wm. A.....Memphis, Tenn.
Mortland, Herbert E.....Hardin, Ill.
Morgan, John H.....Rolla, Mo.
Moore, Henry C.....St. James, Mo.
Morris, Edwin J.....Rolla, Mo.
Norton, Benj. H..... .....Sedalia, Mo.
Nemnich, Otto H.....Florissant, Mo.
Persons, James.....Butte, Mont.
Pickles, James L.....DeSoto, Mo.

Rogers, Charles B.....Neosho, Mo.
Schaberg, Benj .....Clayton, Mo.
Todd, Harry D.....St. Joseph, Mo.

SPECIAL.

Chamberlain, Louis.....Rolla, Mo.
Christie, Louis P.....Butte, Mont.
Colley, Hylton.....Auckland, New Zealand.
Curtis, Leslie V.....St. Louis, Mo.
Davis, Frank J.....Salt Lake City, Utah.
Fish, F. T.....Davenport, Ia.
Hauber, Mathias .....Grant City, Mo.
Hasler, Thomas Allan.....Springfield, Mo.
Harrison, Carrol.....Butte, Mont.
Heller, Robert.....Rolla, Mo.
Hoyt, H. C .....Joplin, Mo.
Holman, Thomas H.....Caledonia, Mo.
Johnson, J. S.....Kaufman, Tex.
Johnson, Wm.....Rolla, Mo.
Jewell, Adellen H.....Dillon, Mo.
Lewis, R. W.....Johnstown, Pa.
Love, Clarence.....Rolla, Mo.
Martinez, Louis D.....Saltillo, Mex.
Menough, Walter S .....Wellsville, O.
Mitchell, Maude B.....Rolla, Mo.
Millard, Homer S.....Houston, Mo.
Seay, Minnie G.....New York City.
Scott, Lewis L.....Rolla, Mo.
James F. Trotter.....Ouray, Col.
Walker, Robert F.....Phelps County, Mo.
Whitaker, Fred.....Durango, Col.
Webb, Ray H.....Sioux City, Ia.
Welch, James L.....Phelps County, Mo.

ACADEMIC.

Anson, Hattie.....Rolla, Mo.
Brene, Flora.....Dillon, Mo.
Cox, Katherine .....Rolla, Mo.
Dickerson, Bessie M.....Rolla, Mo.
German, Mabel.....Rolla, Mo.
Heller, Miriam L.....Rolla, Mo.
Hooker, Ethel.....Vest, Mo.
Holman, W. V .....Lebanon, Mo.
Hutcheson, Leslie.....Rolla, Mo.
Arthur Knapp.....Rolla, Mo.
Owen, Blanche.....Rolla, Mo.
Phariss, Lulu.....Rolla, Mo.
Scott, Ethel M.....Rolla, Mo.
Scott, Dennis.....Rolla, Mo.

SUMMARIES.

By Classes:

Graduates	7
Seniors	12
Juniors	17
Sophomores	22
Freshmen	24
Special	32
Academic	12
Total	125

By States, Territories and Foreign Countries.

Missouri	82
Illinois	7
Iowa	3
Colorado	5
New York	2
Ohio	1
Montana	4
Utah	1
Texas	2
Pennsylvania	2
Tennessee	4
New Mexico	1
Massachusetts	1
Kansas	1
New Zealand	1
Germany	1
Mexico	7
Total	125

INDEX.